A new approach to handle complex geometries in multi-scale analysis

N. MOËS, M. CLOIREC and P. CARTRAUD

Ecole Centrale de Nantes
GeM Institute (CNRS)
1 Rue de la Noe, 44321 Nantes, FRANCE
nicolas.moes@ec-nantes.fr

It is a common fact that as we go down to lower scales, the geometrical complexity rises either because of randomness or because of the heterogeneity of the micro-constituents, or both.

This difficulty is on top of another more studied difficulty : how to bring the information of the microscopic fields to the macro analysis ("homogenization") and, vice-versa, how to localize the macro-field to a small region of interest ("localization").

The presentation will focus on the two preceeding issues using the so-called eXtended Finite Element approach (X-FEM). This approach was initially developped to describe cracks on meshes which are not conforming to the cracks [1].

The X-FEM uses the partition of unity technique [2] to enrich the continuous finite element field with discontinuous field, thus allowing for a crack to exist on the mesh. Later, this technique was also used to describe material interfaces (surface of discontinuity in the derivative of the displacement field) [3]. The material interfaces could be located anywhere on a given mesh. Simple single meshes could be used to analyze very complex or random microstructures.

Concerning the transition from micro to macro scale and vice-versa, the partition of unity offers also new horizons. These will be discussed.

Regarding the applications, we focus on the computation of representative volume of reference (RVE) and the introduction of details on structures (small cracks, hole, rivet, ...).

References

[1] N. Moës and J. Dolbow and T. Belytschko: A finite element method for crack growth without remeshing, *Int. Journal. Num. Meth. Eng.*, Vol. 46, pp.131–150, 1999.

[2] I. Babuška and I. Melenk: Partition of unity method, *Int. Journal. Num. Meth. Eng.*, Vol. 40, pp.727–758, 1997.

[3] N. Moës and M. Cloirec and P. Cartraud and J.-F. Remacle: A computational approach to handle complex microstructure geometries, *Comp. Meth. Appl. Mech. and Eng.*, Vol. 192, pp.3163–3177, 2003.